APPENDIX 10A

Civil Engineering Design Criteria

APPENDIX 10A

Civil Engineering Design Criteria

This appendix summarizes the codes, standards, criteria and practices that will be generally used in the design and construction of civil engineering systems for CVEC. More specific project information will be developed during execution of CVEC to support detailed design, engineering, material procurement specification and construction specifications as required by the California Energy Commission (CEC).

10A.1 Codes and Standards

The design of civil engineering systems for CVEC will be in accordance with the laws and regulations of the federal government, the State of California, the county, the city and industry standards. The current issue or edition of the documents at the time of filing of this Application for Certification (AFC) will apply, unless otherwise noted. In cases where conflicts between the cited documents exist, requirements of the more conservative document will be used.

A summary of general codes and industry standards applicable to the civil engineering design and construction follows.

- American Association of State Highway and Transportation Officials (AASHTO) Standards and Specifications
- American Concrete Institute (ACI) - Standards and Recommended Practices
- American Institute of Steel Construction (AISC) - Standards and Specifications
- American National Standards Institute (ANSI) - Standards
- American Society of Testing and Materials (ASTM) - Standards, Specifications and Recommended Practices
- American Water Works association (AWWA) - Standards and Specifications
- American Welding Society (AWS) - Codes and Standards
- Asphalt Institute (AI) - Asphalt Handbook
- California Building Code (CBC)
- California Department of Transportation, Standards and Specifications
- California Energy Commission - Recommended Seismic Design Criteria for Non-Nuclear Generating Facilities in California
- Concrete Reinforcing Steel Institute (CRSI) - Standards
- Factory Mutual (FM) - Standards
- National Fire Protection Association (NFPA) - Standards
- Steel Structures Painting Council (SSPC) - Standards and Specifications

10A.1.1 Engineering Geology Codes, Standards, and Certifications

Engineering geology activities will conform to the applicable federal, state and local laws, regulations, ordinances and industry codes and standards.

10A.1.2 Federal

None are applicable.

10A.1.3 State

The Warren-Alquist Act, PRC, Section 25000 et seq. and the CEC Code of Regulations (CCR), Siting Regulations, Title 20 CCR, Chapter 2, require that AFC address the geologic and seismic aspects of the project.

The California Environmental Quality Act (CEQA), PRC 21000 et seq. and the CEQA Guidelines require that potentially significant effects, including geologic hazards, be identified and a determination made as to whether they can be substantially reduced.

10A.1.4 County

California State Planning Law, Government Code Section 65302, requires each county to adopt a general plan, consisting of nine mandatory elements, to guide its physical development. Section 65302(f) requires that a seismic safety element be included in the general plan.

The CVEC development activities will require certification by a Professional Geotechnical Engineer and a Professional Engineering Geologist during and following construction, in accordance with the 1998 California Building Code (CBC), Appendix 33. The Professional Geotechnical Engineer and the Professional Engineering Geologist will certify the placement of earthen fills and the adequacy of the site for structural improvements, as follows:

- Both the Professional Geotechnical Engineer and the Professional Engineer will address CBC Appendix 33, Sections 3309 (Grading Permit Requirements), 3312 (Cuts), 3315 (Drainage and Terracing, 3316 (Erosion Control), and 3318 (Completion of Work).
- The Professional Geotechnical Engineer will also address CBC Appendix 33, Sections 3314 (Setbacks).

Additionally, the Professional Engineering Geologist will present findings and conclusions pursuant to PRC, Section 25523 (a) and (c); and 20 CCR, Section 1752 (b) and (c).

APPENDIX 10B

Structural Engineering Design Criteria

APPENDIX 10B

Structural Engineering Design Criteria

10B.1 Introduction

This appendix summarizes the codes, standards, criteria and practices that will be generally used in the design and construction of structural engineering systems for the Facility. More specific project information will be developed during execution of the project to support detailed design, engineering, material procurement specification and construction specifications.

10B.2 Codes and Standards

The design of structural engineering systems for the project will be in accordance with the laws and regulations of the federal government, the State of California and the industry standards. The current issue or edition of the documents at the time of filing of this Application for Certification (AFC) will apply, unless otherwise noted. In cases where conflicts between the cited documents exist, requirements of the more conservative document will be used.

The following codes and standards have been identified as applicable, in whole or in part, to structural engineering design and construction of power plants:

- California Building Code (CBC), 1998 Edition
- American Institute of Steel Construction (AISC):

    a. Manual of Steel Construction - 9th Edition

    b. Specification for the Design, Fabrication and Erection of Structural Steel for Buildings - ASD

    c. Specification for Structural Joints Using ASTM A325 or A490 Bolts

    d. Code of Standard Practice for Steel Buildings and Bridges

- American Concrete Institute (ACI):

    a. ACI 318 - 99, Building Code Requirements for Structural Concrete
    b. ACI 301 - 99, Specifications for Structural Concrete for Buildings
    c. ACI 543R - 00, Design, Manufacture, and Installation of Concrete Piles

- American Society of Civil Engineers (ASCE):

    a. ASCE 7-98 - Minimum Design Loads for Buildings and Other Structures

- American Welding Society (AWS):
  a. D1.1 - Structural Welding Code - Steel
  b. D1.3 - Structural Welding Code - Sheet Steel
- Code of Federal Regulations, Title 29 - Labor, Chapter XVII, Occupational Safety and Health Administration (OSHA):
  a. Part 1910 - Occupational Safety and Health Standards
  b. Part 1926 - Construction Safety and Health Regulations
- National Association of Architectural Metal Manufacturer (NAAMM) - Metal Bar Grating Manual
- Hoist Manufacturers Institute (HMI), Standard Specifications for Electric Wire Rope Hoists (HMI 100)
- National Electric Safety Code (NESC), C2-1993
- National Fire Protection Association (NFPA) Standards:
  a. NFPA 850 Fire Protection for Electric Generating Plants
- OSHA Williams-Steiger Occupational Safety and Health Act of 1970
- Steel Deck Institute (SDI) - Design Manual for Floor Decks and Roof Decks
- Design of Large Steam Turbine-Generator Foundations, ASCE 1987

10B.2.1 CEC Special Requirements

Prior to the start of any increment of construction, the proposed lateral force procedures for project structures and the applicable designs, plans and drawings for project structures will be submitted for approval.

Proposed lateral-force procedures, designs, plans, and drawings shall be those for:

- Major project structures
- Major foundations, equipment supports, and anchorage
- Large, field-fabricated tanks
- Turbine/generator pedestal; and
- Switchyard structures

10B.3 Structural Design Criteria

10B.3.1 Datum

Site topographic elevations will be based on an elevation survey conducted using known elevation benchmarks.

10B.3.2 Frost Penetration

The site is located in an area free of frost penetration. Bottom elevation of all foundations for structures and equipment, however, will be maintained at a minimum of 12 inches below the finished grade.

10B.3.3 Temperatures

The design basis temperatures for Civil and structural engineering systems will be as follows:

- Maximum 118° F
- Minimum 25° F

10B.3.4 Subsurface Conditions

Site-specific subsurface data are not available at this time.

10B.3.5 Design Loads

10B.3.5.1 General

Design loads for structures and foundations will comply with all applicable building code requirements.

10B.3.5.2 Dead Loads

Dead loads will consist of the weights of the structure and all equipment of a permanent or semi-permanent nature including tanks, bins, wall panels, partitions, roofing, drains, piping, cable trays, bus ducts, and the contents of tanks and bins measured at full operating capacity. The contents of the tanks and bins, however, will not be considered as effective in resisting structure uplift due to wind forces; but will be considered as effective for seismic forces.

10B.3.5.3 Live Loads

Live loads will consist of uniform floor live loads and equipment live loads. Uniform live loads are assumed equivalent unit loads that are considered sufficient to provide for movable and transitory loads, such as the weights of people, portable equipment and tools, small equipment or parts, which may be moved over or placed on the floors during maintenance operations, and planking. The uniform live loads will not be applied to floor areas that will be permanently occupied by equipment.

Lateral earth pressures, hydrostatic pressures, and wheel loads from trucks will be considered as live loads.

Uniform live loads will be in accordance with ASCE Standard 7, but will not be less than the following:

a.	Roofs	20 psf
b.	Floors and Platforms (Steel grating and checkered plates)	100 psf

In addition, a uniform load of 50 psf will be used to account for piping and cable trays, except that where the piping and cable loads exceed 50 psf, the actual loads will be used.

Furthermore, a concentrated load of 5 kips will be applied concurrently to the supporting beams of the floors to maximize stresses in the members, but the reactions from the concentrated loads will not be carried to the columns.

c.	Floors (Elevated Concrete floors)	100 psf

In addition, elevated concrete slabs will be designed to support an alternate concentrated load of 2 kips in lieu of the uniform loads, whichever governs. The concentrated load will be treated as a uniformly distributed load acting over an area of 2.5 square feet, and will be located in a manner to produce the maximum stress conditions in the slabs.

d.	Control Room Floor	150 psf
e.	Stairs, Landings and, Walkways	100 psf

In addition, a concentrated load of 2 kips will be applied concurrently to the supporting beams for the walkways to maximize the stresses in the members, but the reactions from the concentrated loads will not be carried to the columns.

f.	Pipe Racks	100 psf

Where the piping and cable tray loads exceed the design uniform load, the actual loads will be used. In addition, a concentrated load of 15 kips will be applied concurrently to the supporting beams for the walkways to maximize the stresses in the members, but the reactions from the concentrated loads will not be carried to the columns.

g. Hand Railings

Hand railings will be designed for either an uniform horizontal force of 50 plf applied simultaneously with a 100 plf uniform vertical live load, or a 200-pound concentrated load applied at any point and in any direction, whichever governs.

h.	Slabs on Grade	250 psf
i.	Truck Loading Surcharge Adjacent to Structures	250 psf
j.	Truck Support Structures	AASHTO-HS-20-44
k.	Special Loading Conditions	Actual loadings

Laydown loads from equipment components during maintenance and floor areas where trucks, forklifts, or other transports will have access, will be considered in the design live loads.

Live loads may be reduced in accordance with the provisions of UBC Section 1606.

Posting of the floor load capacity signs for all roofs, elevated floors, platforms and walkways will be in compliance with the OSHA Occupational Safety and Health Standard, Walking and Working Surfaces, Subpart D. Floor load capacity for slabs on grade will not be posted.

10B.3.5.4 Earth Pressures

Earth pressures will be in accordance with the recommendations contained in the project-specific geotechnical report.

10B.3.5.5 Groundwater Pressures

Hydrostatic pressures due to groundwater or temporary water loads will be considered.

10B.3.5.6 Wind Loads

The wind forces will be calculated in accordance with CBC 1998 with a basic wind speed of 80 mph and a 'C' exposure category.

10B.3.5.7 Seismic Loads

Structures will be designed and constructed to resist the effects of earthquake loads as determined in CBC 1998, Section 1630. The site is located on seismic zone 4. The occupancy category of the structure is 3 (Special Occupancy Structure) and corresponding importance factor (I) is 1.0. Other seismic parameters will be obtained from the geotechnical report.

10B.3.5.8 Snow Loads

Snow loads will not be considered.

10B.3.5.9 Turbine-Generator Loads

The combustion turbine-generators and the steam-turbine generators loads for pedestal and foundation design will be furnished by the equipment manufacturers, and will be applied in accordance with the equipment manufacturers' specifications, criteria and recommendations.

10B.3.5.10 Special Considerations for Steel Stacks

Steel stacks will be designed to withstand the normal and abnormal operating conditions in combination with wind loads and seismic loads, and will include the along-wind and across-wind effects on the stacks. The design will meet the requirements of ASME/ANSI STS-1-1986, "Steel Stacks," using allowable stress design method, except that increased allowable stress for wind loads, as permitted by AISC, will not be used.

10B.3.5.11 Special Considerations for Structures and Loads During Construction

For temporary structures, or permanent structures left temporarily incomplete to facilitate equipment installations, or temporary loads imposed on permanent structures during construction, the allowable stresses may be increased by 33 percent.

Structural backfill may be placed against walls, retaining walls, and similar structures when the concrete strength attains 80 percent of the design compressive strength (f'_c), as determined by sample cylinder tests. Restrictions on structural backfill, if any, will be shown on the engineering design drawings.

Design restrictions imposed on construction shoring removal that are different from normal practices recommended by the ACI Codes will be shown on engineering design drawings.

Metal decking used as forms for elevated concrete slabs will be evaluated to adequately support the weight of concrete plus a uniform construction load of 50 psf, without increase in allowable stresses.

10B.4 Design Bases

10B.4.1 General

Reinforced concrete structures will be designed by the strength design method, in accordance with ACI 318, "Building Code Requirements for Structural Concrete."

Steel structures will be designed by the working stress method, in accordance with AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

Allowable soil bearing pressures for foundation design will be in accordance with the "Final Subsurface Investigation and Foundation Report" for the Facility.

10B.4.2 Factors of Safety

The factor of safety for all structures, tanks, and equipment supports will be as follows:

- Against Overturning 1.50
- Against Sliding 1.50 for Wind Loads
  1.10 for Seismic Loads
- Against Uplift Due to Wind 1.50
- Against Buoyancy 1.25

10B.4.3 Allowable Stresses

Calculated stresses from the governing loading combinations for structures and equipment supports will not exceed the allowable limits permitted by the applicable codes, standards and specifications.

10B.4.4 Load Factors and Load Combinations

For reinforced concrete structures and equipment supports, using the strength method, the strength design equations will be determined based on CBC 1998, Sections 1612.2, 1612.4, 1909.2 and using ACI-318-99 Eqs (9-2), (9-3). The Allowable Stress Design load combinations of CBC 1998 section 1612.3 will be used to assess soil bearing pressure and stability of structures per CBC 1998 Sections 1805 and 1629.1, respectively.

Steel framed structures will be designed in accordance with CBC 1998, Chapter 22, Divisions I, III and IV and the AISC Specification for the Structural Steel Buildings, Allowable Stress Design and Plastic Design, June 1, 1989. Connections will conform to Research Council on Structural Connections of the Engineering Foundation Specification for Structural Joints.

10B.5 Construction Materials

10B.5.1 Concrete and Grout

The design compressive strength (f'_c) of concrete and grout, as measured at 28 days, will be as follows:

- Electrical ductbank encasement and lean concrete backfill (Class L-1) — 2000 psi
- Structural concrete (Class S-1) — 3000 psi
- Structural concrete (Class S-2) — 4000 psi
- Grout (Class G-1) — 5000 psi

The classes of concrete and grout to be used will be shown on engineering design drawings or indicated in design specifications.

10B.5.2 Reinforcing Steel

Reinforcing steel bars for concrete will be deformed bars of billet steel, conforming to ASTM A 615, Grade 60.

Welded wire fabric for concrete will conform to ASTM A 185.

10B.5.3 Structural and Miscellaneous Steel

Structural and miscellaneous steel will generally conform to ASTM A 36, ASTM A 572, or ASTM A992 except in special situations where higher strength steel is required.

High strength structural bolts, including nuts and washers, will conform to ASTM A 325 or ASTM A 490.

Bolts other than high strength structural bolts, will conform to ASTM 307, Grade A.

10B.5.4 Concrete Masonry

Concrete masonry units will be hollow, normal weight, non-load bearing Type I conforming to ASTM C 129.

Mortar will conform to ASTM C 270, Type M.

Grout will conform to ASTM C 476.

10B.5.5 Other Materials

Other materials for construction, such as anchor bolts, shear connectors, concrete expansion anchors, embedded metal, etc., will conform to industry standards and will be identified on engineering design drawings or specifications.

APPENDIX 10C

Mechanical Engineering Design Criteria

APPENDIX 10C

Mechanical Engineering Design Criteria

10C.1 Introduction

This appendix summarizes the codes, standards, criteria and practices that will be generally used in the design and construction of mechanical engineering systems for CVEC. More specific project information will be developed during execution of CVEC to support detailed design, engineering, material procurement specification and construction specifications as required by the California Energy Commission (CEC).

10C.2 Codes and Standards

The design of mechanical engineering systems for CVEC will be in accordance with the laws and regulations of the federal government, the State of California, the county, the city and industry standards. The current issue or edition of the documents at the time of filing of this Application for Certification (AFC) will apply, unless otherwise noted. In cases where conflicts between the cited documents exist, requirements of the more conservative document will be used.

A summary of general codes and industry standards applicable to the mechanical engineering design and construction follows.

California Building Code

Uniform Mechanical Code

Uniform Plumbing Code

ASME Boiler and Pressure Vessel Code

ASME/ANSI 1331.1 Power Piping Code

ASME Performance Test Codes

ASME Standard TDP-1

ANSI B16.5, B16.34, and B133.8

American Boiler Manufacturers Association (ABMA)

American Gear Manufacturers Association (AFMA)

Air Moving and Conditioning Association (AMCA)

American Petroleum Institute (API) - except for electrical requirements

American Society for Testing and Materials (ASTM)

American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)

American Welding Society (AWS)

Cooling Tower Institute (CTI)

Heat Exchange Institute (HEI)

Manufacturing Standardization Society (MSS) of the Valve and Fitting Industry

National Fire Protection Association (NFPA)

10C.3 Mechanical Engineering General Design Criteria

10C.3.1 General

The systems, equipment, materials, and their installation that will be designed in accordance with the applicable codes; industry standards; and local, state, and federal regulations, as well as the design criteria; manufacturing processes and procedures; and material selection, testing, welding, and finishing procedures specified in this section.

Detailed equipment design will be performed by the equipment vendors in accordance with the performance and general design requirements specified by Calpine. Equipment vendors will be responsible for using construction materials suited for the intended use.

Asbestos will not be used in the materials and equipment supplied. Where feasible, materials will be selected to withstand the design operating conditions, including expected ambient conditions, for the design life of the plant. It is anticipated that some materials will require replacement during the life of the plant due to corrosion, erosion, etc.

10C.3.2 Pumps

Pumps will be sized in accordance with industry standards. Where feasible, pumps will be sized for maximum efficiency at the normal operating point. Pumps will be designed to be free from excessive vibration throughout the operating range.

10C.3.3 Tanks

Large outdoor storage tanks will not be insulated.

Overflow connections and lines will be provided. Maintenance drain connections will be provided for complete tank drainage.

Manholes, where provided, will be at least 18 in. in diameter and hinged to facilitate removal. Storage tanks will have ladders and cleanout doors as required to facilitate access/maintenance. Provisions will be included for proper tank ventilation during internal maintenance.

10C.3.4 Heat Exchangers

The surface condenser will be designed in accordance with Heat Exchanger Institute (HEI) standards. Other heat exchangers will be provided as components of mechanical equipment packages and may be shell-and-tube or plate type. Heat exchangers will be designed in accordance with Tubular Exchanger Manufacturers Association (TEMA) or manufacturer’s standards. Fouling factors will be specified in accordance with TEMA.

10C.3.5 Pressure Vessels

Pressure vessels will include the following features/ appurtenances:

- Process, vent, and drain connections for startup, operation, and maintenance
- Materials compatible with the fluid being handled
- A minimum of one manhole and one air ventilation opening (e.g., handhole) where required for maintenance or cleaning access
- For vessels requiring insulation, shop-installed insulation clips spaced not greater than 18 in. on center
- Relief valves in accordance with the applicable codes

10C.3.6 Piping and Piping Supports

Stainless steel pipe may be Schedule 5S or 10S where design pressure permits. Underground piping may be high-density polyethylene (HDPE) or polyvinyl chloride (PVC) where permitted by code, operating conditions, and fluid properties. In general, water system piping will be HDPE or PVC where embedded or underground and carbon steel where above ground.

Piping systems containing steam will be of welded construction. Threaded joints will not be used in piping used for steam, lubricating oil, and CTG natural gas service. Natural gas piping components will not use synthetic lubricants. Victaulic, or equal, couplings will be used for low energy aboveground piping, where feasible.

Piping systems will have high point vents and low point drams. Drains with restricting orifices or steam traps with startup and blowdown drains and strainers/crud traps will be installed in low points of steam lines where condensate can collect during normal operation.

Steam piping systems and steam drain lines in the plant will be sloped in the direction of steam flow. Condensate collection in piping systems will be avoided by installing automatic drain devices and manual devices as appropriate.

Steam lines fitted with restricting devices, such as orifices in the process runs, will include adequate drainage upstream of the device to prevent water from collecting in lines.

Hose and process tubing connections to portable components and systems will be compatible with the respective equipment suppliers' standard connections for each service. Stainless steel piping will be used for the lubricating oil systems.

10C.3.7 Valves

10C.3.7.1 General Requirements

Valves will be arranged for convenient operation from floor level where possible and, if required, will have extension spindles, chain operators, or gearing. Hand-actuated valves will be operable by one person.

Valves will be arranged to close when the handwheel is rotated in a clockwise direction when looking at the handwheel from the operating position. The direction of rotation to close the valve will be dearly marked on the face of each handwheel.

The stops that limit the travel of each valve in the open or closed position will be arranged on the exterior of the valve body. Valves will be fitted with an indicator to show whether they are open or closed; however, only critical valves will be remotely monitored for position.

Valve materials will be suitable for operation at the maximum working pressure and temperature of the piping to which they are connected. Steel valves will have cast or forged steel spindles. Seats and faces will be of low friction, wear-resistant materials. Valves in throttling service will be selected with design characteristics and of materials that will resist erosion of the valve seats when the valves are operated partly closed.

Valves operating at less than atmospheric pressure will include means to prevent air in-leakage. No provision will be made to repack valve glands under pressure.

10C.3.7.2 Drain and Vent Valves and Traps

Drains and vents in 900 pound class or higher piping and 900°F or higher service will be double-valved.

Drain traps will include air cock and easing mechanism. Internal parts will be constructed from corrosion-resistant materials and will be renewable.

Trap bodies and covers will be cast or forged steel and will be suitable for operating at the maximum working pressure and temperature of the piping to which they are connected. Traps will be piped to drain collection tank or sumps and returned to the cycle if convenient.

10C.3.7.3 Low Pressure Water Valves

LP water valves will be the butterfly type of cast iron construction. Cast iron valves will have cast iron bodies, covers, gates (discs), and bridges; the spindles, seats, and faces will be bronze. Fire protection valves will be UL-approved butterfly valves meeting NFPA requirements.

10C.3.7.4 Instrument Air Valves

Instrument air valves will be the ball type of bronze construction, with valve face and seat of approved wear-resistant alloy.

10C.3.7.5 Nonreturn Valves

Nonreturn valves for steam service will be in accordance with ANSI standards and properly drained. Nonreturn valves in vertical positions will have bypass and drain valves. Bodies will have removable access covers to enable the internal parts to be examined or renewed without removing the valve from the pipeline.

10C.3.7.6 Motor-Actuated Valves

Electric motor actuators will be designed specifically for the operating speeds, differential and static pressures, process line flowrates, operating environment and frequency of operations for the application. Electric actuators will have self-locking features. A handwheel and declutching mechanism will be provided to allow handwheel engagement at any time except when the motor is energized. Actuators will automatically revert back to motor operation, disengaging the handwheel, upon energizing the motor.

The motor actuator will be placed in a position relative to the valve that prevents leakage of liquid, steam, or corrosive gas from valve joints onto the motor or control equipment.

10C.3.7.7 Safety and Relief Valves

Safety valves and/or relief valves will be provided as required by code for pressure vessels, heaters, and boilers. Safety and relief valves will be installed vertically. Piping systems that can be over-pressurized by a higher pressure source will also be protected by pressure relief valves. Equipment or parts of equipment that can be over-pressurized by thermal expansion of the contained liquid will have thermal relief valves. HRSG safety valves will be flanged.

10C.3.7.8 Instrument Root Valves

Instrument root valves will be specified for operation at the working pressure and temperature of the piping to which they are connected. Test points and sample lines in systems that are 600 pound class or higher service will be double-valved.

10C.3.8 Heating, Ventilating, and Air Conditioning

HVAC system design will be based on site ambient conditions.

Except for the HVAC systems serving the control room, maintenance shop, lab areas and administration areas, the systems will not be designed to provide comfort levels for extended human occupancy.

Air conditioning will include both heating and cooling of the inlet filtered air. Air velocities in ducts and from louvers and grills will be low enough not to cause unacceptable noise levels in areas where personnel are normally located.

Fans and motors will be mounted on anti-vibration bases to isolate the units from the building structure. Exposed fan outlets and inlets will be fitted with guards. Wire guards will be specified for belt-driven fans and arranged to enclose the pulleys and belts.

Air filters will be housed in a manner that facilitates removal. The filter frames will be specified to pass the air being handled through the filter without leakage.

Ductwork, filter frames, and fan casings will be constructed of mild steel sheets stiffened with mild steel flanges and galvanized. Ductwork will be the sectional bolted type and will be adequately supported. Duct joints will be leaktight.

Grills and louvers will be of adjustable metal construction.

10C.3.9 Thermal Insulation and Cladding

Parts of CVEC requiring insulation to reduce heat loss or afford personnel safety will be thermally insulated. Minimum insulation thickness for hot surfaces near personnel will be designed to limit the outside lagging surface temperature to a maximum of 140°F.

The thermal insulation will have as its main constituent calcium silicate, foam glass, fiberglass, or mineral wool, and will consist of pre-formed slabs or blankets, where feasible.

Asbestos materials will be prohibited. An aluminum jacket or suitable coating will be provided on the outside surface of the insulation. Insulation system materials, including jacketing, will have a flame spread rating of 25 or less when tested in accordance with ASTM E 84.

Insulation at valves, pipe joints, steam traps, or other points to which access may be required for maintenance will be specified to be removable with a minimum of disturbance to the pipe insulation. At each flanged joint, the molded material will terminate on the pipe at a distance from the flange equal to the overall length of the flange bolts to permit their removal without damaging the molded insulation. Steam trap stations will be “boxed” for ease of trap maintenance and freeze protection.

Outdoor, above ground insulated piping will be clad with textured aluminum of not less than 30 mil thickness and frame reinforced. At the joints, the sheets will be sufficiently overlapped and caulked to prevent moisture from penetrating the insulation.

Design temperature limits for thermal insulation will be based on system operating temperature during normal operation.

Outdoor and underground insulation, if required, will be moisture resistant.

10C.3.10 Testing

Hydrostatic testing, including pressure testing at 1.5 times the design pressure, will be specified and performed for pressure boundary components where an in-service test is not feasible or permitted by code.

10C.3.11 Welding

Welders and welding procedures will be certified in accordance with the requirements of the applicable codes and standards before performing any welding. Indexed records of welder qualifications and weld procedures will be maintained.

10C.3.12 Painting

Except as otherwise specified, equipment will receive the respective manufacturer’s standard shop finish. Finish colors will be selected from among the paint manufacturer’s standard colors.

Finish painting of uninsulated piping will be limited to that required by OSHA for safety or for protection from the elements.

Piping to be insulated will not be finish painted.

10C.3.13 Lubrication

The types of lubrication specified for CVEC equipment will be suited to the operating conditions and will comply with the recommendation of the equipment manufacturers.

The initial startup charge of flushing oil will be the equipment manufacturer’s standard lubricant for the intended service. Subsequently, such flushing oil will be sampled and analyzed to determine whether it can also be used for normal operation or must be replaced in accordance with the equipment supplier's recommendations.

Rotating equipment will be splash lubricated, force lubricated, or self-lubricated. Oil cups will be provided as necessary. Where automatic lubricators are fitted to equipment, provision for emergency hand lubrication will also be specified. Where applicable, equipment will be designed to be manually lubricated while in operation without the removal of protective guards. Lubrication filling and drain points will be readily accessible.

APPENDIX 10D

Electrical Engineering Design Criteria

APPENDIX 10D

Electrical Engineering Design Criteria

10D.1 Introduction

This appendix summarizes the codes, standards, criteria and practices that will be generally used in the design and construction of electrical engineering systems for CVEC. More specific project information will be developed during execution of CVEC to support detailed design, engineering, material procurement specification and construction specifications as required by the California Energy Commission (CEC).

10D.2 Codes and Standards

The design of electrical engineering systems for CVEC will be in accordance with the laws and regulations of the federal government, the State of California, the county, the city and industry standards. The current issue or edition of the documents at the time of filing of this Application for Certification (AFC) will apply, unless otherwise noted. In cases where conflicts between the cited documents exist, requirements of the more conservative document will be used.

A summary of general codes and industry standards applicable to the control engineering design and construction follows.

American National Standards Institute (ANSI)

American Society for Testing and Materials (ASTM)

Anti-Friction Bearing Manufacturers Association (AFBMA)

Insulated Cable Engineers Association (ICEA)

Institute of Electrical and Electronics Engineers (IEEE)

Illuminating Engineering Society (IES)

National Electrical Code (NEC)

National Electrical Manufacturers Association (NEMA)

National Electrical Safety Code (NESC)

National Fire Protection Association (NFPA)

Underwriters Laboratories, Inc. (UL)

10D.3 Switchyard and Transformers

10D.3.1 Switchyard

The switchyard will be air-insulated. The switchyard will consist of sulphur hexa-flouride (SF6) circuit breakers for the transformers and lines to the grid, with disconnect switches on each side of the breakers. Each line will be equipped with the appropriate instrument transformers for protection and metering. Instrument transformers will also be used for generator synchronizing. Surge arresters will be provided for the outgoing lines in the area of the takeoff towers.

The SF6 breakers may be of either the dead or live tank design with two bushing current transformers on each bushing. Disconnect switches shall be vertical. Switches will be located on each side of the breakers to isolate the breaker, and one switch will be located at each line termination or transformer connection for isolation of the lines or transformer for maintenance. Instrument transformers (current and capacitive voltage transformers) will be included for protection. Separate instrument transformers will be used for metering.

Aluminum alloy tubular bus will be used. Cable connections between the tube bus and equipment will be ACSR or AAC cable. Tube and cables will meet all electrical and mechanical design requirements.

The switchyard design will meet the requirements of the National Electrical Safety Code - ANSI C2.

A grounding grid will be provided to control step and touch potentials in accordance with IEEE Standard 80, Safety in Substation Grounding. All equipment, structures and fencing will be connected to the grounding grid of buried conductors and ground rods, as required. The substation ground grid will be tied to the plant ground grid.

Lightning protection will be provided by shield wires and/or lightning masts. The lightning protection system will be designed in accordance with IEEE 998 guidelines and local utility practice.

All faults shall be detected, isolated, and cleared in a safe and coordinated manner as soon as practical to insure the safety of Equipment, Personnel and the Public. Protective relaying will meet IEEE requirements and will be coordinated with the utilities requirements.

Each bus will be provided with a high impedance differential relay system. Each outgoing line will be provided with line protection as required by the local transmission provider. Each circuit breaker will be provided with independent breaker failure relay protection schemes. Breaker failure protection will be accomplished by fault detector relays and timing relays for each breaker. Each high voltage breaker will have 2 redundant trip coils.

Interface with the utility supervisory control and data acquisition (SCADA) system and the California ISO will be provided. Interface will be at the interface terminal box and RTU. Remote Terminal Units (RTUs) will allow interface and remote control of the switchyard.

Revenue metering will be provided recording net power to the electrical grid. Additional meters to record startup power received from the electrical grid will be installed. Meters and the metering panel will be provided.

10D.3.2 Transformers

Each generator will be connected to the 230 kV switchyard through a separate 230 kV step-up transformer. The step-up transformers will be designed in accordance with ANSI standards C57.12.00, C57.12.90, and C57.116. The main transformers will be two-winding, delta-wye, OA/FA/FA. The neutral point of the HV winding will be solidly grounded. Each main step-up transformer will have metal oxide surge arrestors adjacent to the HV terminals and will have manual de-energized ("no-load") tap changers located in the HV wings.

CVEC facility power will be supplied through unit auxiliary transformers connected upstream of the combustion turbine generator circuit breakers. Two-winding, delta-wye 15 kV to 4.16 kV transformers will be provided.

APPENDIX 10E

Control Engineering Design Criteria

APPENDIX 10E

Control Engineering Design Criteria

10E.1 Introduction

This appendix summarizes the codes, standards, criteria and practices that will be generally used in the design and construction of control engineering systems for CVEC. More specific project information will be developed during execution of CVEC to support detailed design, engineering, material procurement specification and construction specifications as required by the California Energy Commission (CEC).

10E.2 Codes and Standards

The design of control engineering systems for CVEC will be in accordance with the laws and regulations of the federal government, the State of California, the county, the city and industry standards. The current issue or edition of the documents at the time of filing of this Application for Certification (AFC) will apply, unless otherwise noted. In cases where conflicts between the cited documents exist, requirements of the more conservative document will be used.

A summary of general codes and industry standards applicable to the control engineering design and construction follows.

American National Standards Institute (ANSI)

American Society of Mechanical Engineers (ASME)

The Institute of Electrical and Electronics Engineers (IEEE)

Instrument Society of America (ISA)

National Electrical Manufacturers Association (NEMA)

National Electrical Safety Code (NESC)

National Fire Protection Association (NFPA)

American Society for Testing and Materials (ASTM)

10E.3 Control Systems Design Criteria

10E.3.1 General Requirements

Pneumatic signal levels, where used, will be 3-15 psig for electric-to-pneumatic converter outputs, and valve positioner inputs.

The primary sensor full-scale signal level, other than thermocouples, will be between 10 mV and 125 V.

10E.3.2 Pressure Instruments

In general, pressure instruments will have linear scales with units of measurement in pounds per square inch gauge.

Pressure gauges will have either a blowout disk or a blowout back and an acrylic or shatterproof glass face.

Pressure gauges on process piping will be resistant to plant atmospheres.

Siphons will be installed on pressure gauges in steam service as required by the system design. Steam pressure sensing transmitters or gauges mounted above the steam line will be protected by a loop seal.

Pressure test points will have isolation valves and caps or plugs. Pressure devices on pulsating services will have pulsation dampers.

10E.3.3 Temperature Instruments

In general, temperature instruments will have scales with temperature units in degrees Fahrenheit. Exceptions to this are electrical machinery RTDs and transformer winding temperatures, which are in degrees Celsius.

Dial thermometers will have 4½- or 5-inch-in-diameter (minimum), dials and white faces with black scale markings and will be every-angle type and bimetal actuated. Dial thermometers will be resistant to plant atmospheres.

Temperature elements and dial thermometers will be protected by thermowells except when measuring gas or air temperatures at atmospheric pressure. Temperature test points will have thermowells and caps or plugs.

RTDs will be either 100 ohm platinum or 10 ohm copper, ungrounded, three-wire circuits (R_{100}/R_0-1.385). The element will be spring-loaded, mounted in a thermowell, and connected to a cast iron head assembly.

Thermocouples will be single-element, ungrounded, spring-loaded, Chromel-Constantan (ANSI Type E) for general service. Thermocouple heads will be the cast type with an internal grounding screw.

10E.3.4 Level Instruments

Reflex-glass or magnetic level gauges will be used. Level gauges for high-pressure service will have suitable personnel protection.

Gauge glasses used in conjunction with level instruments will cover a range that is covered by the instrument. Level gauges will be selected so that the normal vessel level is approximately at gauge center.

A single remote water level indicating system will be provided for each HRSG drum.

10E.3.5 Flow Instruments

Flow transmitters will be the differential pressure type with the range matching the primary element. In general, linear scales and charts will be used for flow indication and recording.

The flow element for feedwater flow to each HRSG will be laboratory calibrated venturi flow nozzles.

In general, feedwater flow meters will be temperature compensated when the water temperature is greater than approximately 250°F, critical steam flow meters will be temperature and/or pressure compensated, and airflow measurements will be temperature compensated.

10E.3.6 Control Valves

Control valves in throttling service will generally be the globe-body cage type with body materials, pressure rating, and valve trims suitable for the service involved. Other style valve bodies (e.g., butterfly, eccentric disk) may also be used when suitable for the intended service.

Valves will be designed to fail in a safe position.

Control valve body size will not be more than two sizes smaller than line size, unless the smaller size is specifically reviewed for stresses in the piping.

Control valves in 600 class service and below will be flanged where economical. Where flanged valves are used, minimum flange rating will be ANSI 300 Class.

Critical service valves will be defined as ANSI 900 Class and higher valves in sizes larger than 2 inches.

Severe service valves will be defined as valves requiring anticavitation trim, low noise trim, or flashing service, with differential pressures greater than 100 psid.

In general, control valves will be specified for a noise level no greater than 85 dBA when measured 3 feet downstream and 3 feet away from the pipe surface.

Valve actuators will use positioners and the highest pressure, smallest size actuator, and will be the pneumatic-spring diaphragm or piston type. Actuators will be sized to shut off against at least 110 percent of the maximum shutoff pressure and designed to function with instrument air pressure ranging from 60 to 125 psig.

Handwheels will be furnished only on those valves that can be manually set and controlled during system operation (to maintain plant operation) and do not have manual bypasses.

Control valve accessories, excluding controllers, will be mounted on the valve actuator unless severe vibration is expected.

Solenoid valves supplied with the control valves will have Class H coils. The coil enclosure will normally be a minimum of NEMA 4 but will be suitable for the area of installation. Terminations will typically be by pigtail wires.

Valve position switches (with input to the DCS for display) will be provided for MOVs and open/close pneumatic valves. Automatic combined recirculation flow control and check valves (provided by the pump manufacturer) will be used for pump minimum-flow recirculation control. These valves will be the modulating type.

10E.3.7 Instrument Tubing and Installation

Tubing used to connect instruments to the process line will be 3/8-inch or 1/2-inch outside diameter, copper or stainless steel as necessary for the process conditions.

Instrument tubing fittings will be the compression type. One manufacturer will be selected for use and will be standardized as much as practical throughout the plant.

Differential pressure (flow) instruments will be fitted with three-valve manifolds; two-valve manifolds will be specified for other instruments as appropriate.

Instrument installation will be designed to correctly sense the process variable. Taps on process lines will be located so that sensing lines do not trap air in liquid service or liquid in gas service. Taps on process lines will be fitted with a shutoff (root or gauge valve) close to the process line. Root and gauge valves will be main-line class valves.

Instrument tubing will be supported in both horizontal and vertical runs as necessary. Expansion loops will be provided in tubing runs subject to high temperatures. The instrument tubing support design will allow for movement of the main process line.

10E.3.8 Pressure and Temperature Switches

Field-mounted pressure and temperature switches will have either NEMA Type 4 housings or housings suitable for the environment.

In general, switches will be applied such that the actuation point is within the center one-third of the instrument range.

10E.3.9 Field-Mounted Instruments

Field-mounted instruments will be of a design suitable for the area in which they are located. They will be mounted in areas accessible for maintenance and relatively free of vibration and will not block walkways or prevent maintenance of other equipment. Freeze protection will be provided.

Field-mounted instruments will be grouped on racks. Supports for individual instruments will be prefabricated, off-the-shelf, 2-inch pipestand. Instrument racks and individual supports will be mounted to concrete floors, to platforms, or on support steel in locations not subject to excessive vibration.

Individual field instrument sensing lines will be sloped or pitched in such a manner and be of such length, routing, and configuration that signal response is not adversely affected.

Local control loops will generally use a locally mounted indicating controller (pressure, temperature, flow, etc.).

Liquid level controllers will generally be the nonindicating, displacement type with external cages.

10E.3.10 Instrument Air

Branch headers will have a shutoff valve at the takeoff from the main header. The branch headers will be sized for the air usage of the instruments served. Each instrument air user will have a shutoff valve and filter at the instrument.

APPENDIX 10F

Chemical Engineering Design Criteria

APPENDIX 10F

Chemical Engineering Design Criteria

10F.1 Introduction

This appendix summarizes the codes, standards, criteria and practices that will be generally used in the design and construction of chemical engineering systems for CVEC. More specific project information will be developed during execution of CVEC to support detailed design, engineering, material procurement specification and construction specifications as required by the California Energy Commission (CEC).

10F.2 Codes and Standards

The design of chemical engineering systems for CVEC will be in accordance with the laws and regulations of the federal government, the State of California, the county, the city and industry standards. The current issue or edition of the documents at the time of filing of this Application for Certification (AFC) will apply, unless otherwise noted. In cases where conflicts between the cited documents exist, requirements of the more conservative document will be used.

A summary of general codes and industry standards applicable to the chemical engineering design and construction follows.

- American National Standards Institute (ANSI)
- American Society of Mechanical Engineers (ASME)
- American Society for Testing and Materials (ASTM)
- Occupational Safety and Health Administration (OSHA)
- Steel Structures Painting Council Standards (SSPC)
- Underwriters Laboratories (UL)
- American Waterworks Association AWWA)

10F.3 General Criteria

10F.3.1 Design Water Quality

10F.3.1.1 Raw Water

The Fresno-Clovis WWTF will supply the CVEC all general water requirements such as service water and fire fighting water, as well as process needs for the HRSGs, auxiliary boiler, combustion turbines, and evaporative cooling tower.

Typical water analyses for the Fresno-Clovis WWTF water supplies are presented in Section 8.14.

10F.3.1.2 Demineralized Water System

Distillate from the zero liquid discharge system brine concentrator will be the primary source of makeup to the demineralized water system. Service water will supplement the brine concentrator distillate to the extent that additional makeup water is required. The high quality demineralized water will provide makeup to the steam cycle and auxiliary boiler. In addition, cycle makeup water will be used also to supply water for various other uses such as combustion turbine inlet air fogging and combustion turbine water washes.

The demineralized water will be the highest quality practical. Minimum quality requirements for cycle makeup water will be as follows.

- Total dissolved solids - 0.1mg/l
- Silica as SiO_2 - 0.005 mg/l
- Specific conductance - 0.1 μS/cm
- pH - 6.5 to 7.5

10F.3.1.3 Construction Water

Water for use during construction will be supplied by local suppliers.

10F.3.1.4 Fire Protection Water

The source of water for fire protection will be dedicated portions of the associated water storage tanks.

10F.3.2 Chemical Conditioning

10F.3.2.1 Cycle Chemical Conditioning

Condensate-feedwater chemical conditioning will consist of an oxygen scavenger supplemented as required by a volatile, and a neutralizing amine for pH control.

HRSG chemical feed will consist of a mixture of disodium, trisodium, and hexameta phosphates to control boiler water pH and to minimize scale formation and provide boiler water buffering capacity.

10F.3.2.2 Circulating Water System Chemical Conditioning

Circulating water chemical conditioning will consist of chemicals to minimize the formation of mineral scale and biofouling. Scaling will be controlled by the use of sulfuric acid for alkalinity adjustment in conjunction with scale inhibitors. Chlorination utilizing oxidizing biocide will be used to minimize biofouling of the condenser tubes and the cooling tower

10F.3.2.3 Closed-Cycle System Chemical Conditioning

Bypass chemical feeders will provide water conditioning chemicals to the closed loop auxiliary cooling system. Makeup water to the closed systems will be condensate quality and an inhibitor will be used for corrosion control.

10F.3.3 Chemical Storage

10F.3.3.1 Storage Capacity

Chemical storage tanks will, in general, be sized to store a minimum of 8,000 gallons. Two 12,000-gallon tanks will be provided for the storage of anhydrous ammonia for the SCR systems.

10F.3.3.2 Containment

Chemical storage tanks containing corrosive fluids will be surrounded by curbing. Curbing and drain piping design will allow a full tank capacity spill without overflowing the curbing. For multiple tanks located within the same curbed area, the largest single tank will be used to size the curbing and drain piping. For outdoor chemical containment areas, additional containment volume will be included for stormwater.

10F.3.3.3 Closed Drains

Waste piping for volatile liquids and wastes with offensive odors will use closed drains to control noxious fumes and vapors.

10F.3.3.4 Coatings

Tanks, piping, and curbing for chemical storage applications will be provided with a protective coating system. The specific requirements for selection of an appropriate coating will be identified prior to equipment and construction contract procurements.

10F.3.4 Wastewater Treatment

Metal cleaning wastes from pre-operational and operational chemical cleaning of the boiler systems of the HRSG will be collected, treated, and disposed offsite by the chemical cleaning contractor. Cooling tower blowdown and other plant process wastewaters will be collected and treated in the zero liquid discharge treatment system. The majority of the wastewater will be recycled for reuse within the plant. The remaining wastewater will consist of a concentrated brine solution that will be dried to solid non-hazardous waste.

Sanitary wastewater will be discharged to the City of San Joaquin's sanitary sewer system.

APPENDIX 10G

Geologic and Foundation Design Criteria

APPENDIX 10G

Geologic and Foundation Design Criteria

10G1 Introduction

This appendix includes the results of the preliminary subsurface investigation, and geotechnical assessment for the project to support the Application for Certification (AFC).

This appendix contains a description of the site conditions, and preliminary foundation related subsurface conditions. Soil related hazards addressed include soil liquefaction, hydrocompaction (or collapsible soils), and expansive soils. Preliminary foundation and earthwork considerations are addressed based on the results of general published information available for the project area and collected for the AFC, and established geotechnical engineering practices.

Information contained in this appendix reflects the codes, standards, criteria and practices generally used in the design and construction of site and foundation engineering systems for the facility. More specific project information will be developed during execution of the project to support detailed design, engineering, material procurement specification and construction specifications.

10G2 Scope of Work

The scope of geotechnical services for the preparation of this appendix included preparing this appendix to include an assessment of soils-related hazards, a summary of preliminary foundation and earthwork considerations, and preliminary guidelines for inspection and monitoring of geotechnical aspects of construction based on available published data as analyzed in Section 8.15 of this AFC.

10G3 Site Conditions

The site is located on the southeast intersection of West Colorado Avenue and Manning Avenue, bounded by Springfield Avenue to the south. The site topography is relatively flat. Elevations range from 145 to about 170 feet above sea level. The site currently drains towards the north and east into the existing stream channels. The general area is primarily flat terrain, increasing in elevation to approximately 580 feet to the west near the western terminus of the proposed gas line (approximately 20+ miles to the west).

Currently the property is covered by an agricultural crop (cotton).

10G4 Site Subsurface Conditions

10.G4.1 Stratigraphy

Generalized stratigraphy is discussed in Section 8.15. Borings will be performed at the project site to verify the soil consistency and characteristics.

10G4.2 Seismicity/Ground Shaking

The project site is subject to the probability of seismic activities. No known faults traverse through the local soils in or near the site, and the site is not located in an Alquist-Priolo Earthquake Fault Zone as defined by Special Publication 42 (revised 1997) published by the California Division of Mines and Geology (CDMG). The nearest fault systems are the Coast Range Sierran Block blind thrust fault, located approximately 22 miles southwest of the project site, and the Nuñez Fault, located approximately 25 miles to the west. The San Andreas Fault is approximately 50 miles to the southwest. Per UBC diagrams, the site is located in Seismic Zone 3, and the western end of the gasline terminates in Seismic Zone 4.

The project site is susceptible to ground shaking during major earthquakes from the San Andreas Fault. The seismic risk to structures depends upon the distance to the epicenter; the characteristics of the earthquake, the geologic, groundwater, and soil conditions underlying the structures and their vicinity. Due to the site distance from the above faults and the subsurface conditions, maximum ground acceleration would be expected to be on the order of about 0.2g. Per the preliminary Geotechnical Evaluation (Klienfelder, September 2001), using a probabilistic modeling procedure, the estimated ground acceleration having a 10 percent probability of exceedance in 50 years is less than 0.25g. The gasline approaches the Coast Range Sierran Block blind thrust zone near its western terminus. Ground activity up to 0.6g could be expected. A site response characteristics study should be performed for the project site.

10G4.3 Ground Rupture

Ruptures along the surface trace of a fault tend to occur along lines of previous faulting. There is no evidence of potentially active fault trace at the nearby site; and thus the primary hazard of surface rupture at the project site is expected to be negligible. However, a ground rupture study at the project site should be carried out to verify this assumption.

10G4.4 Liquefaction Potential

Soil liquefaction is a phenomenon in which saturated cohesionless soils are subject to a temporary but essentially total loss of shear strength under the reversing cyclic shear stresses associated with earthquakes. Based on the anticipated relative density of the cohesionless sediments near the project site, coupled with low groundwater table in the region, it is expected that there is low potential for significant damage due to liquefaction.

10G4.5 Ground Water

Groundwater is expected to occur at approximately 30 feet below ground surface. The groundwater table has to be determined and verified at the project site.

10G5 Assessment of Soil-Related Hazards

10G5.1 Liquefaction

Soil liquefaction is a process by which loose, saturated, granular deposits lose a significant portion of their shear strength due to pore water pressure buildup resulting from cyclic loading, such as that caused by an earthquake. Soil liquefaction can lead to foundation bearing failures and excessive settlements when:

- The design ground acceleration is high (up to 0.4g)
- The water level is relatively shallow
- Low SPT blow counts are measured in granular deposits (suggesting low soil density)

The results of the subsurface investigation at the nearby site indicate no soils with a potential for liquefaction. However, this must be verified by the subsurface investigation as mentioned above.

10G5.2 Expansive Soils

Soil expansion is a phenomenon by which clayey soils expand in volume as a result of an increase in moisture content, and shrink in volume upon drying. Expansive soils are usually identified with index tests, such as percentage of clay particles and liquid limit. It is generally accepted that soils with liquid limits larger than about 50 percent, i.e., soils that classify as high plasticity clays (CH) or high plasticity silts (MH), may be susceptible to volume change when subjected to moisture variations.

Laboratory test results for representative soil samples at the top 10 feet below grade should be tested to determine overall soil expansiveness. The soils near the project site at the Fresno Slough have been mapped and are likely to be present under the proposed gas and water lines at the site. A soil investigation will be performed at the project site.

10G5.3 Collapsible Soils

Soil collapse (hydrocompaction) is a phenomenon that results in relatively rapid settlement of soil deposits due to addition of water. This generally occurs in soils having a loose particle structure cemented together with soluble minerals or with small quantities of clay. Water infiltration into such soils can break down the interparticle cementation, resulting in collapse of the soil structure. Collapsible soils are usually identified with index tests, such as dry density and liquid limit, and consolidation tests where soil collapse potential is measured after inundation under load.

Based on the available data, the potential for soil collapse at the site is expected to be remote. However, it has to be verified by testing of the soil samples retrieved from borings.

10G6 Preliminary Foundation Considerations

10G6.1 General Foundation Design Criteria

For satisfactory performance, the foundation of any structure must satisfy two independent design criteria. First, it must have an acceptable factor of safety against bearing failure in the foundation soils under maximum design load. Second, settlements during the life of the structure must not be of a magnitude that will cause structural damage, endanger piping connections or impair the operational efficiency of the facility. Selection of the foundation type to satisfy these criteria depends on the nature and magnitude of dead and live loads, the base area of the structure and the settlement tolerances. Where more than one foundation type satisfies these criteria, then cost, scheduling, material availability and local practice will probably influence or determine the final selection of the type of foundation.

An evaluation of the information collected for the AFC indicates that no adverse foundation-related subsurface and ground water conditions would be encountered that would preclude the construction and operation of the proposed structures. The site can be considered suitable for development of the proposed structures, pursuant to completion of a geotechnical investigation, and the preliminary foundation and earthwork considerations discussed in this appendix.

10G6.2 Shallow Foundations

Completion of the geotechnical investigation will determine if the proposed structures can be supported directly on the native soils. Shallow foundation construction will require the earthwork measures discussed in Section 10G7.

Allowable bearing pressures will include a safety factor of at least 3 against bearing failures. Settlements of footings are expected to be limited to 1 inch, and differential settlement between neighboring foundations to less than 1/2 inch. Tanks can usually undergo much larger settlements.

Frost depth is likely to be less than 5 inches at the site, but will be confirmed through a geotechnical investigation. Pursuant to a geotechnical investigation, exterior foundations and foundations in unheated areas should be placed at a depth of at least 1 foot below the ground surface for protection. Interior footings in permanently heated areas can be placed at nominal depths. The minimum recommended width is 3 feet for spread footings and 2 feet for wall footings.

10.G6.3 Deep Foundations

Compressible soils are not expected based on information analyzed for the AFC. However, if compressible soils are present at the project site, which would preclude use of shallow foundations mentioned above, piles are needed. A typical pile could be a 12-inch or 14-inch square precast-prestressed concrete pile based on geotechnical investigation. These types of piles are expected to develop allowable loads of 60 to 80 tons in compression, 20 tons in uplift, and 4 tons laterally. The length, size, allowable bearing, uplift, and lateral capacity of the piles for the project site should be determined using available software programs.

10G6.4 Corrosion Potential and Ground Aggressiveness

Corrosivity tests should be conducted to determine whether the site soils to be non-corrosive or corrosive for buried steel based on the chloride content and pH values.

10G7 Preliminary Earthwork Considerations

10G7.1 Site Preparation and Grading

There are no trees, structures, or debris to be removed at the project site. The subgrade preparation would include the complete removal of all vegetation (agricultural crop) and topsoil. The majority of the vegetation on the site consists of cotton plants with a maximum root depth of a few inches. Topsoil can be stockpiled and may be reused in remote areas of the site where no future construction is expected.

As discussed in Sections 8.9, 8.14, and 8.16 and shown on Proposed Drainage Facilities (Figure 8.14-4), site grading will include fill to bring the site to a level grade. The site fill work should be performed as detailed below. All soil surfaces to receive fill should be proof rolled with a heavy vibratory roller or a fully-loaded dump truck to detect soft areas.

10G7.2 Temporary Excavations

It is anticipated that confined temporary excavations at the site will be required during construction for the installation of the circulation water pipes and the cooling tower forebay. All excavations should be sloped in accordance with OSHA requirements. Sheet piling could also be used to support any excavation. The need for internal supports in the excavation will be determined based on the final depth of the excavation. Any excavation below the water table should be dewatered using well points installed prior to the start of excavation. Since the water table is approximately 30 feet below the surface, the need for dewatering is not expected.

10G7.3 Permanent Slopes

Cut and fill slopes shall be 2h:1v maximum. Embankments for creek diversions shall be 5h:1v maximum.

10G7.4 Backfill Requirements

All fill material must be free of organic matter, debris or clay balls, with a maximum size not exceeding 2 inches. Structural fill must also be well graded and granular. Granular material with similar specifications can be used for pipe bedding, except that the maximum size should not exceed 1/2 inch. Based on the available site grading, it is not anticipated that any fill material would be available from on-site.

Structural fill should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D 1557 when used for raising the grade throughout the site, below footings or mats, or for rough grading. Fill placed behind retaining structures may be compacted to 90 percent of the maximum dry density as determined by ASTM D 1557. Initially, structural fill should be placed in lifts not exceeding 8 inches loose thickness. Thicker lifts may be used pursuant to approval based on results of field compaction performance. The moisture content of all compacted fill should fall within 3 percentage points of the optimum moisture content measured by ASTM D 1557, except compact the top 12 inches of subgrade to 95 percent of ASTM D 1557 maximum density.

Pipe bedding can be compacted in 12-inch lifts to 90 percent of the maximum dry density as determined by ASTM D 1557. Common fill to be placed in remote and/or unsurfaced areas may be compacted in 12-inch lifts to 85 percent of the maximum dry density as determined by ASTM D 1557.

10G8 Inspection and Monitoring

A California-registered Geotechnical Engineer or Engineering Geologist should monitor geotechnical aspects of foundation construction and/or installation, and fill placement. At a minimum the Geotechnical Engineer/Engineering Geologist should monitor the following activities:

- All surfaces to receive fill should be inspected prior to fill placement to verify that no pockets of loose/soft or otherwise unsuitable material were left in place and that the subgrade is suitable for structural fill placement.
- All fill placement operations should be monitored by an independent testing agency. Field compaction control testing should be performed regularly and in accordance with the applicable specification to be issued by the Geotechnical Engineer.
- All pile load testing and initial stages of production pile installation must be witnessed by the Geotechnical Engineer.
- Settlement monitoring of significant foundations and equipment is recommended on at least a quarterly basis during construction and the first year of operation, and then semi-annually for the next 2 years.

10G9 Site Design Criteria

10G9.1 General

The project will be located in the city of San Joaquin, California. The approximate 85-acre site is relatively flat, with no existing permanent type of structures. The site would be accessible from the proposed extension of Cherry Lane.

10G91.2 Datum

The site grade varies between El. 145 to 170 feet, mean sea level, based on the 1929 National Geodetic Vertical Datum (NGVD). Final site grade elevation will be determined.

10G92 Foundation Design Criteria

10G9.1 General

Reinforced concrete structures (spread footings, mats and deep foundations) will be designed consistent with Appendix 10B.

Allowable soil bearing pressures for foundation design will be in accordance with this Appendix.

10G9.2 Ground Water Pressures

Hydrostatic pressures due to ground water or temporary water loads will be considered.

10G9.3 Factors of Safety

The factor of safety for structures, tanks and equipment supports with respect to overturning, sliding, and uplift due to wind and buoyancy will be as defined in Appendix 10B, Structural Engineering Design Criteria.

10G9.4 Load Factors and Load Combinations

For reinforced concrete structures and equipment supports, using the strength method, the load factors and load combinations will be in accordance with Appendix 10B, Structural Engineering Design Criteria.

10G10 References

California Building Code 1998.

Department of the Navy (1982). "Identification and Classification of Soil and Rock," Chapter 1 in *Soil Mechanics Design Manual 7.1*, Naval Facilities Engineering Command, Alexandria, VA.

Appendix 10G

Attachment 10G-1

KLEINFELDER
An employee owned company

September 21, 2001
File No.: 21-4192-02

Mr. Frank Middleton
Calpine Corporation
6700 Koll Center Parkway, Suite 200
Pleasanton, CA 94566

SUBJECT: Preliminary Geotechnical Evaluation
Proposed Calpine Central Valley Energy Center
Colorado Road and Springfield Avenue
San Joaquin, California

Dear Mr. Middleton:

Kleinfelder is pleased to present the following information on the general geotechnical and geologic conditions anticipated for the proposed Central Valley Energy Center to be located in San Joaquin, California. The purpose of this letter is to provide comments regarding the anticipated site soil and groundwater conditions, regional and local geology, site seismicity, liquefaction potential and pertinent geologic hazards to aid in preparing the environmental component of a California Energy Commission application for the proposed plant.

Our comments are based on discussions with the James Irrigation District and review of test boring logs from the general area (within about 4 miles of the site). Based on the geologic formation of the general area, this data is believed adequate to characterize the general geotechnical conditions. Site specific exploration is being scheduled as part of the geotechnical investigation associated with design of the plant.

KLEINFELDER 1410 F Street, Fresno, CA 93706 (559) 486-0750 (559) 442-5081 fax

SITE CONDITIONS

Surface

Based on our site visit on September 20, 2001, the site consists of a relatively flat triangular shaped parcel. The power plant site is bounded on the north and west by agricultural property, on the south by Springfield Avenue with agricultural property beyond, and on the east by Southern Pacific Railroad and Colorado Avenue. An irrigation canal trends along the south property line immediately adjacent to Springfield Avenue. At the time of our site visit the parcel supported a mature cotton crop.

Subsurface

The earth material profile within depths influenced by the plant area, consist of alluvial sediment with a geologic age of Holocene. Based on exploration in the general area, the profile is anticipated to consist of surficial mantle of clayey silt and silty clay. This upper horizon will be underlain by interbedded, laterally discontinuous layers of silty sand, sand, clayey silt and sandy silt. The relative consistency of fine grained soil (clay and silts) is expected to range from stiff to very hard. The consistency of sands is anticipated to vary from medium dense to very dense.

Groundwater in the project vicinity is anticipated to be at a depth of about 100 feet. While some fluctuation is the groundwater level may occur overtime, ground water is not anticipated to have any affect on the plant construction or long term performance.

GEOLGOIC CONDITIONS

Regional Geology

The project site lies in the central portion, and near the west side of the Great Valley geomorphic province in central California. This province of California was formed by the filling of a large structural tough or downwarp in the underlying bedrock. The trough is situated between the Sierra Nevada Mountains on the east and the Coast Range Mountains on the west. Both of these mountains ranges were initially formed by uplifts, which occurred during the Jurassic and Cretaceous periods of geologic time (greater than 65 million years ago). Renewed uplift began in the Sierra Nevada during the Tertiary time, and is continuing today. The trough, which underlies the valley, is asymmetrical, with the greatest depths (several thousand feet) of sediments near the western margin. The sediments that fill the trough originated as erosional debris from the adjacent mountains and foothills.

Local Faulting

The project site and its vicinity are located in an area traditionally characterized by low to moderate seismic activity. Faulting and seismic ground shaking is usually associated with known fault systems. Based on a review of the area's Five County Seismic Safety Element (1974), published maps, and our current understanding of the geologic framework and tectonic setting of the proposed facility, there are no known faults which traverse through the local soils in or near the site, and the site is not located in an Alquist-Priolo Earthquake Fault Zone as defined by Special Publication 42 (revised 1997) published by the CDMG. The primary source of seismic shaking is anticipated to be the Coast Ranges Sierran – Block Fault Zone, which is located about 36km southwesterly of the site.

Site Seismology

A deterministic modeling procedure was used to estimate the peak ground motion corresponding to the maximum credible earthquake. The deterministic analysis is based on characteristics of the earthquake and of the causative fault associated with the earthquake. These characteristics include such items as magnitude of the earthquake, distance from the site to the causative fault, and the effects of site soil conditions. The maximum governing event would be a Magnitude 7.5 earthquake on the Coast Ranges – Sierran Block Fault Zone. This fault is located about 36 km southwesterly of the site and would produce a ground acceleration of about 0.2g. This value may be somewhat conservative, in that CDMG is presently considering this fault zone to be a series of smaller segments with associated lower maximum magnitudes.

Using a probabilistic modeling procedure (Uniform Building Code and California Building Code), the estimated ground acceleration having a 10% probability of exceedance in 50 years is less than 0.25g.

Liquefaction

Considering the relatively deep historic groundwater levels, liquefaction of foundation soil would not occur. Based on the anticipated relative density of the cohessionless sediments, liquefaction is unlikely, even if there were a substantial increase in the groundwater elevation.

The site specific geotechnical design study will address liquefaction potential based on actual conditions encountered. Should there be any potential consequence of liquefaction, mitigation measures will be provided.

Seismically Induced settlement

Based on the anticipated relative consistency of the foundation soil and the expected intensity of seismic ground motion, no appreciate seismically induced settlement is anticipated.

The design geotechnical study will analyze dynamic settlement for the actual conditions encountered and the level of cyclic stress induced by the design earthquake. Should any significant seimically induced settlement result, recommendations for mitigation will be provided.

OTHER GEOLOGIC HAZARDS

Landslides and Ground Failure

Strong shaking has the potential for activation of landslides on hillsides, slope failures on creek banks (lurch cracking) and tension cracking in areas underlain by loose, low density soil such as uncompacted fill. Since the site is level and there are no anticipated areas of extensive fill or filled in or existing creek banks, the potential for landslides or other slope failures from earthquake induced ground shaking is low.

Tsunamis, Seiches, Earthquake Induced Flooding

Tsunamis are sea waves of unusual size that occur from significant earthquakes either under the ocean floor or adjacent to shorelines and can travel great distances to impact low-lying communities and developments. Since the site is protected from the sea by the Coast Range, the potential for the site to be affected by tsunami is nil.

A seiche is a free or standing-wave oscillation that occurs in a confined body of water, such as a reservoir or lake. Earthquake generated ground waves, which have a period that matches the natural period of the lake or reservoir, may cause the water to oscillate, which can cause damage to shore line improvements. The County General Plan does not address the potential of seiches. No nearby large bodies of water are present from which a seiche would influence the site.

Potential inundation due to upstream dam failure is not addressed in the General Plan. The seismic adequacy of dams are usually governed by the U.S. Corp of Engineers and California Division of Dam Safety. Considering the distance to the site from water storage reservoirs, site inundation due to a dam failure would be unlikely.

Flooding

Based on the Flood Insurance Rate Maps (No. 065029 1150 B, December 1, 1982) distributed by the Federal Emergency Management Agency, the site is located in Zone C. Zone C was areas outside of the 500-year floodplain with minimal potential for flooding (less than 12-inch). The area may have be updated to the new Zone X designation.

LIMITATIONS

Comments contained in this report are based on our field observations, and our knowledge of and subsurface exploration general area.

We have prepared this report in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the site area at the time of our study. No warranty is expressed or implied.

This report is intended to be used by the client and their consultants only for the purposes stated, within a reasonable time from its issuance.

We appreciate the opportunity to provide this preliminary geotechnical engineering evaluation to Calpine. We trust this information meets your current needs. If there are any questions concerning the information presented in this report, please contact this office at your convenience.

Sincerely,

KLEINFELDER, INC.

David L. Pearson

David L. Pearson, P.E., G.E.
Senior Project Manager

DLP:tjg

cc: Mr. Tom Lagerquist
Peregrine Environmental